SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1910.

GENERAL PHYSICS.

1563. *Volume of a Mercury Meniscus.* **K. Scheel and W. Heuse.** (Ann. d. Physik, 33. 2. pp. 291–295, Aug. 30, 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—In the accurate measurement of gas volumes the volume of the mercury meniscus introduces an error which is not negligible. The authors have determined this volume for a number of cases, using tubes of diams. 28·70, 20·75, 18·40, 16·05, and 13·90 mm., and from their results the following table has been prepared. A systematic difference between the observations for a rising and for a falling meniscus could not be discovered.

VOLUME OF MENISCUS IN MM.^{3}.

Height of Meniscus in mm.	Diam. of Tube in mm.										
	14	15	16	17	18	19	20	21	22	23	24
1·6	157	185	214	245	280	318	356	398	444	492	541
1·7	169	198	229	263	300	340	381	426	475	526	579
1·8	181	211	244	281	320	362	407	455	507	560	616
1·9	194	225	261	300	341	385	433	484	539	595	654
2·0	206	240	278	319	362	409	460	513	571	631	694
2·1	219	256	295	338	384	434	487	543	604	667	735
2·2	233	271	313	358	406	459	515	574	637	704	775
2·3	247	287	331	379	430	485	544	606	672	742	817
2·4	262	303	350	400	454	511	573	639	708	781	859
2·5	276	320	369	422	478	538	602	672	745	821	903
2·6	291	338	388	444	503	565	633	706	782	862	948

T. Lohnstein. (Ibid. pp. 296–307, Aug. 30, 1910.)—Lohnstein gives a formula for the volume of a mercury meniscus in terms of tube diam., height of meniscus, &c. The results of Scheel and Heuse are discussed with reference to this formula, and Lohnstein states that the differences between the volumes calculated from the formula and the observed values are probably due to some slight errors associated with the apparatus used. A. W.

1564. *Theory of Balloon Variometer.* **A. Bestelmeyer.** (Phys. Zeitschr. 11. pp. 763–768, Sept. 1, 1910.)—This paper gives theory relating to the author's modified form of the Hefner-Alteneck variometer for measuring the vertical velocity of balloons; a description of this instrument has previously been given [Abstract No. 5 (1909)]. It is shown that a constant displacement of the variometer (apart from the effect of temperature) corresponds to a definite vertical velocity of the balloon, and is proportional thereto; it is independent of the absolute value of the air pressure, and consequently of the height of the balloon. The effect of temperature and capillarity is considered, and it appears that for practical purposes both can be neglected, the errors arising from these causes only amounting to a few per cent. If the balloon has constant acceleration, the displacement of the variometer gives the instantaneous velocity a few seconds previously. This time of lag for a temperature of 20° C. and a pressure of 760 mm. is about 2 sec., and reaches 4 sec. for a height of 5500 m. and a temperature of —20° C. This result was tested by an experimental method, and the figures obtained were in as close agreement with the theory as could be expected from the difficulties of the experiment. A. W.

1565. *Dependency of Elastic Properties of Cast Iron in bending on its Tensile and Compressive Elasticity.* **H. Herbert.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1387–1393, Aug. 20, and pp. 1441–1445, Aug. 27, 1910.)—Investigating analytically the case of a beam subject to bending when the compressive and tensile moduli of elasticity are not equal, and as a consequence the neutral axis does not lie on the centre of gravity, gives—

$$\sigma_1 = (2M + x \, . \, \delta M/\delta x)/bh\delta\epsilon_1/\delta x \quad \text{and} \quad \sigma_2 = (2M + x \, . \, \delta M/\delta x)/bh\delta\epsilon_2/\delta x,$$

where σ_1 and σ_2 are the tensile and compressive stresses, M the bending moment, ϵ_1 and ϵ_2 the respective extensions and compressions along lines parallel to the neutral axis, and x the inverse of the radius of curvature at a point; b, h have the usual meaning. The beam was loaded with a uniform bending moment; ϵ_1 and ϵ_2 were measured by mirror extensometers, and x was obtained from the relation $x = (\epsilon_1 + \epsilon_2)/h$. The above relations were determined on the beam and subsequently compared with values obtained from tensile and compressive specimens. The theory is clearly modified when initial stresses are taken into account and some interesting curves are given to show the departure from theory owing to this disturbing effect. C. A. M. S.

1566. *Calculation of Stresses in a Rotating Drum.* **R. Lorenz.** (Zeitschr. Vereines Deutsch. Ing. 54. pp. 1397–1403, Aug. 20, 1910.)—The full mathematical discussion of the stresses induced in a rotating drum is given for the two leading cases: (1) when the drum is connected to the axle by two flat discs rigidly attached to the drum at points not at the end; and (2) when the drum is simply supported at the ends. The solution of the stress equation involves functions such as—

$$\sinh (al/2) \cos (al/2) + \cosh (al/2) \sin (al/2)/(\sin al + \sinh al)$$

and—

$$(\sin al - \sinh al)/(\sin al + \sinh al).$$

These and similar functions of a have been calculated and tables and curves prepared so as to readily provide the solution to the two general cases mentioned above. C. A. M. S.

1567. *The Testing of Files.* **W. Ripper.** (Mech. Eng. 26. pp. 330–333, Sept. 23, 1910. Paper read before the British Assoc. at Sheffield, 1910.)—Contains results of the examination of records made on a Herbert file-testing machine, and gives particulars of an improvement made in the design by the author. The action of the machine is briefly as follows: The file to be tested is held rigidly between two headstocks on a reciprocating table. The test-bar, 1 in. square, and 8 ft. long, is supported in a horizontal position on grooved rollers, and is pressed against the file by a weight. By the reciprocating motion of the file acting on the end of the bar, a portion is cut away at each stroke, and by means of a recording arrangement a diagram is obtained showing the relation between the number of inches filed away from the bar and the number of strokes required to do this work. This machine, however, in its original form was found to give unsatisfactory results, as files considered of the best quality gave poor results, files of the same quality were found to give different results, and the two sides of the same file showed considerable differences. The author found that the machine differed in its action from hand filing in one important particular, for, in the machine, the file cut the test-bar in an absolutely constant path, with the result that the face of the test-bar became glazed in appearance, and the file ceased to cut. In the case of hand filing no two strokes are made exactly in the same direction. The author describes his device by means of which the path of the file is no longer a constant one, but slightly changes in direction, stroke by stroke, as in hand filing. As a result of a large number of tests with the modified machine, it has been found that the irregularity of results previously obtained has been removed. C. O. B.

1568. *Compressibilities of Helium and Neon.* **F. P. Burt.** (Faraday Soc., Trans. 6. pp. 19–25; Discussion, pp. 25–26, July, 1910.)—The compressibility coefficient for helium between 0 and 1 atmo. at 0° C. is found to be zero, and for neon + 0·00105. W. H. Sr.

1569. *Aerial Plane Waves of Finite Amplitude.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 84. pp. 247–284, Sept. 15, 1910.)—A closely reasoned memoir difficult to abstract in full detail. It reviews the work of Poisson, Earnshaw, Riemann, Rankine, Stokes, Hugoniot, and others, dwelling especially on the discontinuity that may be anticipated in advancing waves and which it is so difficult for theory to evade. The paper is divided into four parts dealing with (1) Waves of finite amplitude without dissipation; (2) Waves of permanent regime; (3) Permanent regime under the influence of dissipative forces; (4) Resistance to motion through air at high velocities. At the end of the third part it is shown that $\frac{1}{4} \times 10^{-5}$ cm. is the theoretical thickness of the transitional layer of the aerial wave of approximate discontinuity which advances in front of a modern rifle bullet. The photographs of Boys show these layers to be thin; but that, according to calculation, their thickness should be well below the microscopic limit is regarded as surprising. In the fourth part, it is shown that along the axis in front of the nose of an advancing bullet there are two stages in the modifications of pressure and velocity which occur. At a short distance in front along the axis the fluid changes its density, pressure, and temperature suddenly. This first or sudden change is not according to the adiabatic law, but according to Rankine's law (previously discussed in the paper). After passing the place of this sudden change, and fixing attention on parts nearer the nose of the bullet, we are there concerned with the second stage, which is a more gradual change in the state of the fluid and occurs according to the adiabatic law. If the velocity of the bullet is u_0, the normal velocity of sound $a = \sqrt{\gamma p_0/\rho_0}$, the normal pressure p_0 and the pressure at the nose of the bullet p_1, the following numerical values follow, and close the paper :—

$$\frac{\text{Bullet's Speed}}{\text{Sound Speed}} = u_0/a = \quad 1 \qquad 2 \qquad 3 \qquad 4$$

$$\frac{\text{Pressure at Nose}}{\text{Normal Pressure}} = p_1/p_0 = \quad 1{\cdot}90 \qquad 4{\cdot}49 \qquad 11{\cdot}7 \qquad 20{\cdot}7$$

E. H. B.

1570. *Rigid Bodies and the Relativity Principle.* **W. v. Ignatowsky.** (Ann. d. Physik, 33. 3. pp. 607–630, Sept. 22, 1910.)—A mathematical discussion from which the following chief results are obtained: (1) A body which is rigid from the standpoint of the relativity principle must be regarded as a medium which is, if only in appearance, capable of deformation; (2) The propagation of stress in such a medium, in contradiction to the ordinary view of a rigid body, occurs with finite velocity which is smaller, the greater the impressed velocity is. But the velocity of propagation of stress is always greater than that of light. The condition for incompressibility and other matters are also treated. E. H. B.

1571. *Measurement of Surface Tension by Cantor's Method.* **R. Magini.** (Accad. Lincei, Atti, 19. pp. 184–189, Aug. 21, 1910.)—This method consists in measuring the max. pressure necessary to maintain a gas-bubble of given size under a given nozzle, dipped in the liquid to a given depth. Applied to benzene, liquid air, and water, the method has given mean surface tensions of 3·08 mgm./mm., 12·1 dynes/cm., and 7·497 mgm./mm. respectively, which agree closely with those determined by the capillary-wave method. The results, both when determined with the same tube and with different tubes of Pt or glass, show very considerable variation. W. H. Sn.

1572. *Molecular and Electronic Potential Energy.* **W. Sutherland.** (Phil. Mag. 20. pp. 249–266, Aug., 1910.)—In previous papers the author has shown that cohesion can be explained by the attractions between each molecule and its immediate neighbours. For the general case of a homogeneous isotropic substance the most convenient average arrangement of the molecules to be taken as mathematically representative of that of nature is the cubical one, in which case each molecule has six nearest neighbours. Each molecule may be regarded as an electrised sphere analogous to the earth as a magnetised sphere. It has an electric moment, es, say, which may be due to two opposite electron-charges e at a distance s apart. But es may be regarded as the symbol for the electric moment of the molecule, however produced. Outside of the molecule, the electrisation acts like an electric doublet of infinitely small axis, but of finite moment es placed at the centre of the molecule. Place, for simplicity, the electric axis of a molecule parallel to one set of edges in the assumed cubical arrangement. Then in order that a molecule may attract its six immediate neighbours it must have its electric axis similarly directed to those of its two axial neighbours, and oppositely directed to those of its four lateral neighbours. Let R be the distance from its neighbours. Then it attracts its two axial neighbours with a force $6e^2s^2/R^4$ and its four lateral ones with a force $3e^2s^2/R^4$. The mean attraction is $4e^2s^2/R^4$. The forces between the central molecule and the more remote ones will be either repulsions or attractions whose average effect could be calculated. But they can be neglected in comparison with the attractions of the six immediate neighbours and for the following reasons. The molecules in nature are in motion, the directions of their axes are changing. The cubical arrangement of the molecules and the assumed direction of the axes becomes a closer representation of the facts of nature, the smaller the multiple of R to which it is extended from a central molecule. Even for a molecule and its six nearest neighbours at any instant the cubical arrangement is not a true picture. The real state of affairs is a succession of distorted cubical arrangements with a strictly cubical arrangement for a mean. The schematic representation is thus deprived of plasticity if we make one set of dividing planes apply to a large number of molecules. The best way of stating the position is to say that near a molecule the arrangement of other molecules is approximately cubical at any instant, but that the accumulated effects of small departure from the strict cubical arrangement make the relations between any molecule and those which are not its immediate neighbours, not expressible by means of a single cubical arrangement.

On this basis the molecular potential energy is then calculated and a number of kindred matters treated. Thus, the so-called internal molecular pressure, the $K\rho^2$ of Laplace and the a/v^2 of van der Waals is first taken. If m is the mass of a molecule and $\rho = 1/v$ is the density of the substance, $R^3 = m/\rho$ and $K\rho^2 = a/v^2 = 4e^2s^2/R^6 = 4e^2s^2\rho^2/m^2 = 4e^2s^2/m^2v^2$ the potential energy per unit mass is $K\rho$. Surface energy is next dealt with, and the paper concludes with observations on the nature of chemical potential energy. **E. H. B.**

1573. *Seiches of Lake Garda.* **F. Vercelli.** (N. Cimento, **20.** pp. 87–116, Aug., 1910.)—The study of these phenomena by Forel on Lake Geneva, and others, in particular the work of Chrystal [Abstract No. 1698 (1905)], drew attention to the similar manifestations on Italian lakes where they have long been known locally as *sese* or *sesse.* Limnographs were installed at Desenzano and Toscolano on Lake Garda, two registering mareographs at Salò and another limnograph was placed at Riva on the extreme end of the lake. Oscillatory motions of two kinds are distinguished: *uninodal* seiches with one node towards the centre and two ventral segments, one at each end; and binodal seiches, movements with two nodes and an intermediate ventral segment, the other two being one at each end, analogous to the case of vibrating strings. Of the varied theories that of Chrystal referred to above has given the best results, according very well with the observations of these somewhat complicated phenomena. Application of Chrystal's theory was made by that author to the Scotch Lochs Earn and Treig, observation and calculation giving concordant results. These lakes, however, are of small size and very regular shape, whilst Garda is a much larger and more irregular body of water, with numerous bays, islets, and sandbanks, marshy regions, &c. An account of his investigations next follows, and the formulæ for amplitude, position of nodes, speed, and periodic time are given. For the uninodal oscillation the periodic time (supposing the lake of uniform depth) is equal to that which will be required by a progressive oscillation to travel over a canal of double the length. The periodic times of the "higher" waves should be respectively ½, ⅓, ¼, &c., of this, as in the case of an open pipe; but since the *depth in general varies*, the periods are usually incommensurable with this, in real cases occurring in nature. Chrystal's mathematical theory is given in some detail, and is followed by a comparison of the results of theory and experiment, made by V. Teglio and the present author; these show a very satisfactory agreement. The periodic times T_1 and T_2 for the uninodal and binodal seiches, 42 and 28 min. respectively, agree within less than 1 min. of time with the calculated values, and for the higher oscillations an even more satisfactory accordance is found. The author gives a table showing this, together with some discordant results derived from the theories of Du Boys and Merian, which differ widely from the observed values. A figure is also given showing the characteristic forms of the limnographic records, and there follows a description of the method adopted for their study. With regard to the cause of these phenomena, all the observers agree that they owe their origin mainly to variations in atmospheric pressure. It has been found by comparison of records that every disturbance in the microbarogram is accompanied by a corresponding variation of the limnogram. From observations of these records there are also distinguished two classes—the "sudden" seiches, and the "gradual" ones. The former are probably produced by rapid changes of level over the surface of the lake, due to wind or increase of atmospheric pressure, or to sudden changes arising from local hurricanes or storms, heavy rains, &c.; the latter by the action over a part of the lake surface of slight variations in pressure, synchronous in period with those of the seiches which can arise upon it, or by analogous action of the wind, as shown by the anemograph records. Calculations of the amount of energy in seiches show that no greater amount is required to produce these phenomena than is furnished by very moderate agencies. To generate a seiche of mean amplitude, an amount of energy equal to that evolved in the combustion of only 200 gm. of carbon is sufficient. Thus a slight and short shower lasting only 40 seconds, or a rapid variation of not more than 0·5 mm. in the barometer may give rise to one, and so there is no need to look for any other special causes to explain the origin of these phenomena. F. W. H.

1574. *Periodicity of Volcanic Eruptions.* **M. Bogolepow.** (Soc. Imp. Nat. Moscou, Bull. 23, pp. 19–88, 1909.)—The records of 1080 volcanic eruptions during the years 1701–1902 are analysed, and give mean periodicities of 8·1 and 12·5 years. There is also a longer period of undetermined length, which is possibly a 33-year period. By assuming that the interval 1755–1775 consists of two waves and not one as shown in his diagram, the author reduces the average period of the second variation from 12·5 to 11·8 years. These three periodicities in volcanic activity are considered by him to be associated with the 8·8, 11·1, and 33·3-year "pulsations" of the atmosphere as deduced from various atmospheric phenomena. The records also give some indication that a maximum of volcanic activity possibly appears first in equatorial regions and travels towards the poles. The author advocates a theory that an elastic-fluid magma exists under the earth's crust and pulsates, so that waves travel from the equatorial to the polar regions, and the subsequent sinking of the ground causes faulting in rock strata, with accompanying volcanic and seismic activity. A. D. R.

1575. *Determination of Seismic Centres.* **L. Geiger.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 331–349, 1910.)—The author points out the difficulty in determining the distance of earthquake centres by the interval elapsing between the arrival of first- and of second-phase waves. This is chiefly due to the superposition of preliminary tremors on the second-phase waves, with a consequent complication of the seismogram. He prefers to employ only the time of first disturbance of the seismograph, and if this datum is obtained at three stations the problem is determinate. An account is given of the application of the method to observations at n stations ($n = 3$, 4, 5, ...). When $n > 3$ the data are in excess of the requirements, and the method of least squares is then employed. Examples are given for two earthquakes recorded at five and at three stations respectively. A. D. R.

1576. *Electrodynamical Investigation of the Earth's Crust.* **H. Löwy** and **G. Leimbach.** (Phys. Zeitschr. 11. pp. 697–705, Aug. 15, 1910.)—The authors discuss a method of investigating the earth's crust by (1) reflection, and (2) absorption of electric waves sent through the rock strata. In the first method a slanting antenna is erected at some definite point on the earth's surface. Electric waves sent out therefrom pass through the earth, are reflected at the surface of any medium whose dielectric constant differs markedly from that of its surroundings, and are finally received by sloping antennæ at other points on the earth's surface. Maximum effects are obtained at a receiving station for two values of the inclination of the antenna—one corresponds to the direct, the other to the reflected waves. The positions of the wave-front of the reflected waves enables the situation of the reflecting surface to be determined. The method is effective in locating the surface of ground-water, coal seams, and metalliferous strata. In the second method vertical antennæ, 100 m. long, are used in borings about 300 m. deep and at any distances up to 400 km. apart. Experiments are then made to determine in which cases the electric waves can pass through the earth's crust, and in which they are lost by reflection and absorption by certain intervening media. The paper gives an account of the theory of the methods and of various experimental applications which have been made. The authors consider the methods will be useful in locating underground water in arid districts. A. D. R.

1577. *Solar Activity, May 18–19, 1910.* **F. Slocum.** (Astrophys. Journ. 32. pp. 24–25, July, 1910.)—Direct photographs and pictures with monochromatic calcium radiation (H_2) were taken during May with the intention of detecting any abnormal phenomena which might be ascribed to the presence of Halley's comet between the earth and sun. Reproductions of those taken on May 18 are given. Considerable activity is shown on the plates, evidenced by changes in the location and number of small spots, and in the arrangement and intensity of the bridges in the large spots. The calcium spectroheliograms show conspicuous changes in the arrangement of the flocculi. The prominence plates exhibit normal conditions only; on May 18 there were fifteen prominences, but none of unusual size or intensity. C. P. B.

1578. *Photographic Work with the 60-inch Reflector.* **G. W. Ritchey.** (Astrophys. Journ. 32. pp. 26–35, July, 1910. Contribution from the Mount Wilson Solar Observatory, No. 47.)—The first year's work with the 60-in. reflector at Mount Wilson, California, showed that the mirror came very nearly up to its calculated efficiency. One of the chief outstanding difficulties was the change of focus caused by the variations of temperature. Special precautions had been taken in the building of the observatory to minimise the temperature fluctuations as much as possible, and a further improvement was made in July, 1909, by providing a sun-shield of heavy white canvas over the roof of the dome. This reduced the temperature oscillation to a daily range of 10° F., but even with this the apparent change of focus of the mirror amounted to 0·02 in. (0·5 mm.). Further improvement was obtained by enclosing the greater part of the instrument in a thickly padded canopy when not in use. The daily variation was thereby reduced to 8·8° F., and it is hoped to diminish this still more by the use of a refrigerator. By the use of a smaller plate-holder and a "knife-edge" method of focussing it is now possible to make certain that the plane of the photographic plate does not differ from the stellar focus by more than 0·001 in. (0·025 mm.). On the best negatives, with an exposure of 11 hours, perfectly round star-images are obtained, the smallest only 1·08″ in diam. With these instrumental improvements and the use of fine-grained process plates numerous photographs of the globular star-clusters and the spiral nebulæ have been obtained far surpassing any previous attempts. The spiral nebulæ are remarkable for the number of nebulous stars shown clustered amongst their convolutions. Several excellent reproductions accompany the article. C. P. B.

1579. *Circulation of Calcium Vapour in the Sun.* **C. E. St. John.** (Astrophys. Journ. 32. pp. 36–82, July, 1910. Contribution from the Mount Wilson Solar Observatory, No. 48.)—For the interpretation of the photographs obtained by means of spectroheliographs it is necessary to know the precise wave-lengths of the lines employed and their behaviour under varied laboratory conditions. The present paper summarises the results of determinations of wave-lengths of solar standards in terms of arc standards; the measurement of wave-lengths of the absorption line K_3 and the emission line K_2 at different points on the sun's disc; a study of the absolute widths of H and K at the centre and limb, and the vertical distribution of calcium vapour in the sun's atmosphere. C. P. B.

1580. *Rotation of Hydrogen in Solar Atmosphere.* **A. Perot.** (Comptes Rendus, 151. pp. 429–431, Aug. 8, 1910.)—Interference determinations of the solar rotation show that the daily rotation or equatorial velocity for hydrogen is 0·8° greater than that for the reversing layer showing iron, nickel, &c. At latitude 88° 45′ the retardation of hydrogen is 0·6°, and that of the metallic layers 1·1°. Calcium gives intermediate values. [See Abstract No. 1207 (1910).] C. P. B.

1581. *Velocity of Sun's Motion through Space.* **J. C. Kapteyn and E. B. Frost.** (Astrophys. Journ. 32. pp. 83–90, July, 1910.)—As the peculiar velocities of the Orion stars are small, it was considered particularly advantageous to employ them for a series of spectrographic determinations of the sun's velocity. The radial velocity of a considerable number of Orion stars has been determined at the Yerkes Observatory. The deduced velocity is 28·8 km. per sec. C. P. B.

1582. *Polar Filaments on the Sun.* **H. Deslandres.** (Comptes Rendus, 151. pp. 413–417, Aug. 8, 1910.)—In a previous paper [Abstract No. 1076 (1910)] the author has drawn attention to the differences between solar filaments as photographed in calcium or hydrogen light. Further investigation shows that they occupy a region round the pole, not necessarily coinciding with a parallel of solar latitude, but having an average position about 50–70°. In general this polar curve appears to be more developed on the meridians and in the hemisphere where there are no spots. Sometimes they occur simultaneously at both poles, but more generally only at one. It is important to note that whereas the spots are now (1910) well on the way towards minimum, the filaments appear rather to be augmenting. The question is raised as to the possibility of these filaments supplying the material for the formation of the solar corona, projected outwards from the sun by the pressure of radiation. Several features of the solar circulation appear to be similar to those found in the earth's atmosphere. C. P. B.

1583. *Spectrographic Velocity of the Moon.* **K. Laves.** (Astrophys. Journ. 32. pp. 17–23, July, 1910.)—The usual method of computation of the moon's theoretical spectrographic velocity in the line of sight involves a somewhat laborious interpolation, and a modified procedure is outlined whereby with the aid of special tables the operation is very much simplified. These tables are based on the elliptic values of the elements of the moon and earth. C. P. B.

1584. *Sodium in Comets' Tails.* **T. W. Backhouse.** (Roy. Astronom. Soc., M.N. 70. pp. 622–623, June, 1910.)—Referring to the question of the occurrence of sodium as the cause of the yellow colour of certain comets during their approach to perihelion, the author quotes certain notes made during the apparition of Comet Wells (1882*a*), made with a small spectroscope on a 4½-in. refractor. In a note Fowler remarks that it was only a question of whether sodium had been traced in the tail spectrum at a distance greater than 6 or 7 min. of arc from the nucleus. As there is some difficulty in recognising the lines with low-power apparatus, it was suggested that the yellow colour might be due to the yellow band of the high-pressure carbon monoxide spectrum. C. P. B.

1585. *Luminosity of Comets.* **W. L. Dudley.** (Science, 32. pp. 286–288, Aug. 26, 1910.)—The cometary matter is supposed to be a gaseous body with a more or less dense nucleus, acting as a conductor in a constant electric stream which increases in energy as the comet approaches the sun and diminishes as it recedes. As the comet comes closest to the sun it encounters the supposed positive discharge from the solar area, and the illuminated tail may thus be that of the ionised path of the repelled particles. The character of the discharge would of course be greatly modified by the presence of one or more magnetic fields, which are supposed to be produced in the vicinity of the planets, thus possibly accounting for the different characters of cometary tails and the condensations or nodes in the tail material. C. P. B.

1586. *Spectrum of Halley's Comet.* **J. Evershed.** (Roy. Astronom. Soc., M.N. 70. pp. 605–610, June, 1910.)—The first observations of this comet were obtained at Kodaikanal, South India, on the morning of April 18, 1910, when it appeared as a second magnitude star with a tail about 5 degrees long. Photographs were obtained with a portrait lens of 4 in. aperture and 35 in. focal length; also with a silver-on-glass reflector of 9½ in. aperture, two of these being reproduced. The spectrum of the comet was photographed frequently with a small prismatic camera of 2 in. aperture and 11·5 in. focal length, provided with two prisms of 60° angle. On the same plate as the comet spectrum there was also photographed the spectrum of either the star Altair (α Aquilæ) or the planet Venus, for comparison of wave-lengths. All the spectrum plates are essentially similar, and so far as a preliminary inspection shows, there was no change in the relative intensities of the various lines during the period April 21 to May 16. The spectrum consists of three distinct parts: (*a*) continuous spectrum due to the nucleus, on which the Fraunhofer lines were faintly shown; (*b*) a discontinuous spectrum of the gases surrounding the head but not extending into the tail; (*c*) a series of monochromatic images of the tail. Of the head radiations those at wavelengths 3866 and 3890 are the strongest. The tail spectra show the series of lines discovered by Fowler to be due to a form of carbon monoxide at low pressure. The stronger tail images can be traced for about 8 degrees from the head on the plate taken on May 1. On May 3 they appear forked, although the direct pictures of the tail do not show this feature. In general, the spectrum appears to be very similar to that of Comet Daniel (1907*d*). **C. P. B.**

1587. *Systematic Motions of the Bradley Stars.* **S. S. Hough** and **J. Halm.** (Roy. Astronom. Soc., M.N. 70. pp. 568–588, June, 1910.)—In a former paper [Abstract No. 331 (1910)] it was pointed out that from a discussion of the radial velocities of the Kapteyn two-drift systems there appeared to be evidence of a selective distribution of the drift stars. The present paper contains a critical examination of the Bradley proper motions with reference to the distribution of the stars constituting the two drifts. The numbers of stars obtained by analysis of the different proper motions for all sections of the sphere are tabulated and also plotted as curves, in which the existence of two maxima indicates the presence of the two drifts. From these it is at once apparent that the proportion of mixture of the two drifts varies within such wide limits that it is quite impossible to have uniform distribution. The significant feature is that the direction of greatest density of the second drift agrees almost exactly with that diameter which passes through the galaxy, and that the direction of minimum condensation falls in that diameter which meets the celestial sphere closest to the galactic poles. The observed conditions would appear to be satisfied by the assumption that drift I represents an indiscriminate assemblage of stars, through which the sun is moving with a uniform speed. The second drift is probably identical with the galaxy; and on this hypothesis the motion of our solar system would be in a direction opposite to that of the first drift, *i.e.*, towards the point whose co-ordinates are RA = 267° and Decl. + 13°. **C. P. B.**

1588. *Parallax of Fourth-type Stars.* **J. C. Kapteyn.** (Astrophys. Journ. 32. pp. 91–95, July, 1910.)—The fact that up to the present time no star of the fourth or fifth type is known to have a sensible proper motion suggests that these stars have very small parallaxes. The fourth-type star observations have been made by Norlund at Copenhagen, and include data for 140 stars. The parallax for most of these stars is very small, and it is therefore considered that in any endeavour to interpret the spectra of fourth-type stars some account should be taken of the possible selective absorption of light during its passage through space. **C. P. B.**

REFERENCES.

1589. *Length and Time in the Relativity Theory.* **H. v. Mangoldt.** (Phys. Zeitschr. 11. pp. 737–744, Aug. 15, 1910. Paper read before the Westpreussischer Bezirksverein deutsch. Ing.)—A semi-popular *résumé* of the relativity theory as it affects measurements of length and time. **E. H. B.**

1590. *Finite Vibrations of a System about a Configuration of Equilibrium.* **Rayleigh.** (Phil. Mag. 20. pp. 450–456, Sept., 1910.)

LIGHT.

1591. *Scattering of Light by Molecules.* **H. A. Lorentz.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 92–107, Sept. 1, 1910.)—It was pointed out many years ago by Rayleigh that a beam of light can be scattered to all sides not only by particles of dust, but also by the molecules of the medium in which the propagation takes place. If the intensity is diminished in the ratio 1 to e^{-hl} when a distance l is traversed, then for a gas, for instance, $h = 32\pi^3 (\mu - 1)^2/3N\lambda^4$, where μ is the index of refraction, N the number of molecules per unit volume and λ the wave-length. Rayleigh deduced his equation by calculating the energy radiating from the molecules whose particles are put in motion by the incident rays, and by taking into account that the quantities of energy traversing two successive sections of the beam must differ from such other by an amount equal to the energy that is emitted by the molecules lying between those sections. The problem may, however, also be treated in a different manner. In many theories the ordinary absorption of light is explained by a resistance opposing the motion of the vibrating particles and giving rise to a development of heat. Similarly, the extinction which we are now considering may be ascribed to a certain resistance, which, however, is not accompanied by a heating effect, but is intimately connected with the radiation from the molecules. According to the electron theory a force of this kind acts on an electron whenever its velocity v is variable; it is represented by $(e^2/6\pi c^3)\, d^2v/dt^2$, in which e is the electron charge and c the light-speed in ether. The problem is then developed on this basis, and it is shown that both on this method and also by Rayleigh's method the scattering of light is predicted only for a system whose molecules are irregularly distributed. [See also Abstract No. 1655 (1899).] E. H. B.

1592. *Nature of Ultramicroscopic Particles taking part in Majorana-effect.* **M. Tenani.** (Accad. Lincei, Atti, 19. pp. 178–184, Aug. 21, 1910.)—Examining by means of a Cornu photopolarimeter the light diffused by Bravais' iron solution, when placed between the poles of an electromagnet and a beam of plane polarised light passed through it, the author finds the max. polarisation of diffused light occurs at an angle of 90° with the incident beam. This, he concludes, confirms Rayleigh's theory that the corpuscles in suspension in Bravais' iron solution behave as insulated spheres. Replying to Corbino [Abstract No. 912 (1910)] the author's experiments render it very doubtful whether any exact measurements of the magnetic field can be based on the birefringence of Bravais' iron solution. W. H. Sn.

1593. *Rainbow Phenomena.* **W. J. Humphreys.** (Mount Weather Observatory, Bull. 2. 6. pp. 375–376, 1910.)—This paper deals with the conclusions arrived at by Laine from his observation of rainbow phenomena associated with a thunderstorm. Laine observed well-defined primary and secondary rainbows, the colours and curvature of which changed in a quivering or vibratory manner at every peal of thunder. These phenomena were not noticed at the moment of the lightning discharge, but almost exactly at the instant the thunder was heard. According to Pernter's theory of the rainbow, just such changes as these would follow sufficiently rapid alterations in the size of the raindrops concerned in the formation of the bows. Laine concludes that under the influence of acoustical shaking two or more droplets coincide [Abstract No. 228 (1910)]. The author of the present paper considers it far more probable that the conditions that lead to a lightning discharge also lead, commonly, to the production of large drops through rapid condensation and, owing to convection, long suspension. Besides these conditions, favourable to the formation of large drops during thunderstorms, there probably exist, in portions of the cloud, those potential gradients which favour the coalescence of all drops that for any reason chance to collide. Hence we may consider the formation of large raindrops and of loud peals of thunder as more or less concurrent phenomena, rather than as phenomena that are appreciably related to each other in the sense of cause and effect. Therefore the phenomena observed by Laine may be explained as due to large drops that were already formed above the rainbows at the time of the lightning discharge. The lightning-flash was seen at almost the instant that it was found, while the sound reached the observer at about that time when the large drops had fallen down to the level of the bows. A. W.

1594. *Anomalous Dispersion in Sodium Vapour.* **D. Roschdestwensky.** (Zeitschr. wiss. Phot. 9. pp. 37–47, Sept., 1910.)—Using Puccianti's method, a layer of sodium vapour about 5 cm. thick is placed in one arm of the interferometer, and the displacement of the lines caused gives the dispersion curve. As the vapour density increases, the grey region between D_1 and D_2 increases until only a narrow bright band is left, the middle of which corresponds to the minimum of dispersion, *i.e.*, to the inflection point of the dispersion curve; this is much nearer to D_1 than to D_2. Assuming the formulæ for anomalous dispersion, the condition for minimum dispersion gives $m_1/m_2 = [(\lambda_0 - \lambda_1)/(\lambda_2 - \lambda_0)]^3$, where m_1 and m_2 are constants, and this ratio is also contained in the equation to the axis of abscissæ. The values found were $m_1/m_2 = 1{\cdot}86$, refractive index $1 + 18 \times 10^{-4}$, $m_{D_1} = 4{\cdot}4 \times 10^{-14}$; $m_{D_2} = 2{\cdot}4 \times 10^{-14}$, Voigt s $\rho_{D_2} = 1{\cdot}5 + 10^{12}$. One of the chief advantages of the method is that it is independent of the motion of the bands due to temperature-changes. G. E. A.

1595. *Optical Properties of Substances dissolved in very Dilute Solutions.* **C. Chéneveau.** (Annal. Chim. Phys. 21. pp. 36–49, Sept., 1910.)—The author has already shown that the refractive index of a solution can be calculated on the assumption that the quantity n–1 is made up of a constant specific refraction of the solvent plus a constant specific refraction of the solute over the range from 20 to 500 gm. per litre. In the present paper it is shown by an interference method that the optical constant of the solute remains unaltered to a dilution of 0·5 gm. per litre, and is thus quite independent of the ionisation of the salt. T. M. L.

1596. *On Kinematographic Synthesis.* **H. Lehmann.** (Zeitschr. Instrumentenk. 30. pp. 265–274, Sept., 1910.)—In general the film is moved forward in a series of jerks, exposure being made only while the film is at rest. In consequence, there is an alternation of light and dark which causes the well-known disagreeable flicker. The critical frequency at which flicker disappears was shown by Porter to be proportional to the logarithm of the intensity of illumination [see Abstract No. 209 (1908)]. With the aid of Porter's equations, the author's experiments lead to the conclusion that the frequency of change of picture should lie between 88 and 46·8 per sec. This is not the case in practice, since the strength of the film does not allow the necessary speed, and the frequency employed lies between 15 and 25. Helmholtz has shown that there is a change in the critical frequency with change of proportion of the light to the dark interval, and it appears from Marbe's experiments that, beyond a certain frequency, reduction of the dark interval is accompanied by a decrease in the critical frequency. Taking the value 25 for the frequency, the exposure interval should be ten times longer than the time of motion of the picture. This, however, gives 1/275 sec. for the dark interval, which is too small, and in practice the ratio is reduced from 10 to 4 or 5. When coloured light is employed, the critical frequency is less than for white light, the order of the colours with respect to frequency being the same as that given by König's curve of sensitiveness of the eye for the spectrum colours. G. E. A.

1597. *Wave-length Difference by Echelon-Spectroscope.* **P. Gmelin.** (Ann. d. Physik, 33. 1. pp. 17–32, Aug. 5, 1910.)—A method has been worked out for obtaining the difference in wave-length between a spectrum line and one of its components. It is based on the fact that slightly convergent light, after multiple reflection between two half-silvered plane-parallel surfaces, gives rise to Haidinger-Mascart rings. The method is considered analytically, and then applied in the case of the components of the yellow and green mercury lines. In the first case, the author finds that the yellow line 5790 has six components, and he gives the differences $d\lambda$ for these in Ångström units.

G. E. A.

1598. *Damping of Vibrations of Light in Luminous Sodium Vapour and the Zeeman-effect.* **L. Mandelstam.** (Phys. Zeitschr. 11. pp. 752–753, Sept. 1, 1910.)—König has given a simple method of demonstrating the Zeeman-effect qualitatively [Wied. Ann. 63. p. 268 (1897)]. The light from a sodium flame in a magnetic field is allowed to pass through a second similar sodium flame outside the field, and on being examined with a polariscope is found to be partially polarised. The component light vibrating perpendicular to the lines of force is less absorbed by the second flame than the component vibrating parallel to the lines of force—a fact indicating that the different states of polarisation correspond to different wave-lengths. The component which is the less strongly absorbed must be that which, owing to the Zeeman-effect, diverges most from the normal vibration. (The same appearance can be seen, though less clearly, without the aid of the second flame, probably owing to auto-absorption in the first flame itself.) The author has adopted König's arrangement in carrying out some quantitative experiments based on the following ideas. An absorbing flame contains resonators of definite frequency and damping-power. The Zeeman-effect affords a means of putting incident light "out of tune," so to speak, with the vibrations proper to these resonators, by a desired interval. By making a series of measurements of absorption during the continuous process of "putting out of tune," a curve of decrease of absorption can be constructed, which may be likened to a resonance curve. From the form of this curve the damping power of the molecular resonators can be determined. The apparatus is arranged as follows: Two similar sodium flames are provided, one of which is placed between the (plane) poles of a Ruhmkorff electromagnet. When the field is excited, horizontal (say) bands appear in the polariscope. A plane-parallel glass plate is now inserted in the path of the rays, and rotated about a vertical axis until the bands vanish. In the emergent light, thus compensated, the components polarised perpendicular and parallel to the lines of force are equal. Next, the second flame is inserted in the path, and the bands reappear. By means of a second glass plate, placed between the absorbing flame and polariscope, the bands are again made to disappear. From the angle through which the second plate has to be turned for this to happen, the ratio of the two components, polarised at right angles and parallel to the lines of force, of the light emerging from the absorption flame, can be determined. The total absorption, by the second flame, of light of unaltered wave-length, can also be determined. This may be done either photometrically or by making the field so strong that the components out of tune are no longer absorbed. Since the Zeeman separation is a known function of the field, the absorption corresponding to each wave-length of incident light can be determined, and the logarithmic decrement calculated. The measures were somewhat rough, but sufficed to indicate that the log. decrement, due to the damping, was of the order 10^{-6}. A. E.

1599. *Frequency and Damping in Luminous and non-Luminous Sodium Vapour.* **G. v. Ubisch.** (Phys. Zeitschr. 11. pp. 753–756, Sept. 1, 1910.)—[See preceding Abstract.] A preliminary description of experiments by Mandelstam's method for determining the damping of vibrations in a flame from the absorption of a similar flame [see preceding Abstract]. The mode of derivation of the formulæ used in calculating the results is described, and some short tables and curves are given showing the relation between strength of magnetic field, Zeeman separation, and log. decrement of absorption. The values of the last are of the same order, 10^{-6}, as those found by Mandelstam. The investigation was extended to the case where the absorbing gas is non-luminous, a tube containing dark sodium vapour being substituted for the absorbing flame. At lower temperatures, viz., about 200° C., the observed phenomena are the same as with the flame, but on increasing the temperature the appearance changes. The interference bands appear at about 200°, and gradually grow stronger, then diminish again, and vanish at a temperature between 260° and 280°, according to the strength of field. On further heating they reappear, but the polariscope shows that the new bands are not in the same position as the former ones, but rather are complementary to them. The results indicate that a shift (towards the violet) has occurred in the spectral position of the sodium vibration. At 270° C., with strength of field 11,000 gauss, a shift was found amounting to about 1/34th of the distance between the two D lines. The sodium vapour at the temperatures in question was also subjected to ordinary spectroscopic examination with a grating, an Auer burner serving as source. At about 200° C. the Na lines are seen to appear faintly as absorption lines, and they become distinct at 260°–280°, the interval between them being 10–15 times their width. As the temperature is raised they increase quickly in width, and finally merge at about 410°. A. E.

1600. *Secondary Röntgen Rays from Metallic Salts.* **J. L. Glasson.** (Cambridge Phil. Soc., Proc. 15. pp. 437–441, June 14, 1910.)—The paper deals with experiments to determine whether the nature of the characteristic secondary X-radiation from a metal is affected by its state of chemical combination. Röntgen rays were allowed to fall on the salt under investigation, and the character of the secondary radiation was determined in the ordinary way by means of its absorption curve. The radiation from a given metallic salt was found to consist of two parts: (1) A homogeneous radiation having the same absorption coefficient as that of the metal itself; (2) a scattered radiation due to the acid radical, considerably harder than (1). The value of the absorption coefficient of the homogeneous radiation was found to be independent of the valency of the metal in the salt (*e.g.*, $FeSO_4$; Fe_3O_4, Fe_2O_3), while it may even occur in the acid radical itself without affecting the value of λ. E. M.

1601. *Radio-active Recoil.* **L. Wertenstein.** (Comptes Rendus, 151. pp. 469–471, Aug. 16, 1910. Le Radium, 7. pp. 288–294, Oct., 1910.)—In a previous paper the author showed that the atoms of RaB projected by recoil of the α-particles from RaA have a range of about 0·12 mm. in air at atmospheric pressure [Abstract No. 928 (1910)]. The present paper deals with further experiments on the subject. Active deposit from RaEm was deposited on glass and a layer of silver deposited above it. It was found that a layer of silver of thickness 10 $\mu\mu$ allowed most of the recoil particles to pass through, while a layer of thickness 20 $\mu\mu$ completely stopped them; the thickness of silver of mass equivalent to 0·12 mm. air being 16 $\mu\mu$. The range of the recoil RaB-particle in hydrogen was found to be about 0·7 mm. at atmospheric pressure. Experiments on the ionisation close to a source of RaC point to the conclusion that the recoil RaD-particles contribute a measurable amount to the initial ionisation. Experiments on recoil phenomena in RaEm in which RaA was collected on a positively charged plate suggested that on the stoppage of RaA-particles in the gas a small percentage of them become negatively charged. E. M.

1602. *Energy of Radio-active Rays.* **W. Duane.** (Comptes Rendus, 151. pp. 471–473, Aug. 16, 1910.)—In the experiments described a direct heating effect of the α-rays from RaEm has been observed. In the first experiments a differential calorimeter was used, consisting of two flasks filled with hydrogen and connected by a capillary tube containing a drop of xylol. One of the flasks was furnished with a mica window thin enough to allow α-particles to penetrate, and on presenting a strong α-ray source to the window the xylol was deflected, indicating a production of heat. No effect was observed on interposing sheets of Al just thick enough to stop the α-particles. The same effects were observed using a modified apparatus similar to that previously used by the author [see Abstracts Nos. 1078, 1409 (1909)]. The author hopes to obtain quantitative measurements of the energy of the α-rays and also, if possible, of the β- and γ-rays. E. M.

1603. *Alteration in Range of α-Particles in an Electric Field.* **M. Reinganum.** (Akad. Wiss. Heidelberg, Sitz. Ber. Math.-Naturw. Klasse, 8. 1910. Ann. d. Physik, 33. 1. pp. 134–144, Aug. 5, 1910.)—The author has determined the change of range of the α-particles from polonium when they traverse an electric field in the direction of their path [see also Eve, Abstract No. 1485 (1908)]. The α-particles were fired through a piece of thin Al-foil which closed the end of an earthed chamber with an insulated electrode fixed parallel and close to the Al-foil. The ionisation current between the electrode and the foil was observed, this being arranged to correspond to a small portion of the range near the end of the path. The polonium source was charged up to any desired potential and screwed along until the ionisation current was observed to be the same as before, this adjustment being possible owing to the rapid change in the ionisation produced near the end of the range of α-particles. The alteration in the distance of the polonium corresponded to the change in range and for a potential of 10,000 volts was 0·217 mm., which agrees well with the value 0·212 mm. calculated from the known data of the mass and charge of the α-particle. E. M.

1604. ***Rate of Emission of α-Particles from Uranium and its Products.*** **J. N. Brown.** (Roy. Soc., Proc. Ser. A. 84. pp. 151–154, July 28, 1910.)—The object of the experiments was to estimate the number of α-particles emitted per sec. per gm. of Ur in equilibrium with all its products (*i.e.*, as it occurs in pitchblende). The pitchblende was used in films so thin that there was no appreciable absorption of the α-particles by the films themselves, and the α-particles emitted were determined by the scintillations they produced on a zinc sulphide screen. The pitchblende used was analysed to determine its percentage composition of Ur, the latter being precipitated as phosphate; this percentage was 41·80. The final result obtained was $7{\cdot}36 \times 10^{4}$ α-particles per sec. per gm. of Ur; the value obtained by a series of calculations from Rutherford's value for RaC and assuming two α-ray changes in Ur and one each in ionium, Ra, RaEm, RaA, RaC, and polonium, is $9{\cdot}25 \times 10^{4}$. E. M.

1605. ***β-Rays from Radium.*** **L. Kolowrat.** (Comptes Rendus, 151. pp. 525–528, Sept. 5, 1910. Le Radium, 7. pp. 269–275, Sept., 1910.)—Hahn and Meitner have found that a radium salt freed from its emanation and active deposit, emits a very absorbable β-radiation [see Abstract No. 2068 (1909)]. The author has repeated these experiments and obtained results showing a general agreement with them. In the experiments a piece of Pt-foil, containing a little Ra, was heated for several hours to drive off the emanation and active deposit, a thin sheet of Al being then fixed hermetically over it. The intensity and absorbability of the radiation given off was then observed both initially and at subsequent intervals. From these observations it is calculated that a radiation arises from Ra itself, its intensity being about 2 per cent. of the equilibrium β-ray intensity and its absorbability of the order 200 cm^{-1}. Allowance had to be made for a small initial amount of RaEm which it was impossible to get rid of. E. M.

1606. ***Transmission of β-Rays.*** **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 15. pp. 442–458, June 14, 1910.)—In the experiments described the velocity of a beam of homogeneous β-rays was measured by two separate magnetic fields before and after its passage through an absorbing medium. The magnetic deflections were made in evacuated vessels so as to prevent errors due to scattering. It was found that Al caused a small but perceptible diminution in velocity of the rays, without any appreciable disturbance of the homogeneity of the beam; this diminution in velocity, however, being too small to account for the total absorption. Glass screens gave similar results to Al, but, on the other hand, Pt caused the beam to emerge with a fairly wide range of velocities. The author also describes experiments on the law of absorption of homogeneous β-rays by matter, the intensity of the absorbed β-rays being measured by a compensation method in an ionisation chamber so arranged that at whatever angle the rays emerged, their length of path in the chamber was practically the same. With Al the absorption curve was complicated, being neither exponential nor linear [see Wilson, Abstract No. 1888 (1909)], but approximating to a form recently suggested by J. J. Thomson [Abstract No. 1470 (1910)]. The absorption curve for Pt, after an initial steep portion is exponential, this result being attributed to secondary radiation. [See also next Abstract.] E. M.

1607. *Scattering of Homogeneous β-Rays and the Number of Electrons in the Atom.* **J. A. Crowther.** (Roy. Soc., Proc. Ser. A. 84. pp. 226–247, Sept. 15, 1910.)—The phenomenon of the scattering of β-rays by matter appears to be subject to fewer uncertainties than that of absorption, and the present paper deals with its investigation for the purpose of obtaining atomic data. A homogeneous parallel beam of β-rays was sorted out by a magnetic field in an exhausted vessel from the complex β-rays given out by $RaBr_2$ in equilibrium. This beam was directed normally against the scattering material and the intensity of the resultant radiation was measured in different directions by a compensation method. The scattering was found to obey the following laws. (1) For rays of given velocity the intensity I of the radiation contained within a given cone may be expressed by the equation $I/I_0 = 1 - \epsilon^{-kt}$, where t is the thickness of material passed through and k a constant depending on the angle of the cone. (2) For rays of given velocity the most probable angle of emergence is proportional to the square root of the thickness of material traversed by the rays. (3) For rays of different velocities the probable angle of emergence divided by the square root of the thickness traversed is inversely proportional to the product of the mass of the incident β-particle into the square of its velocity. These results are in agreement with those of a recent theoretical solution of J. J. Thomson [Abstract No. 1470 (1910)], part of the theory being abstracted in the paper. From J. J. Thomson's further theoretical results it is found: (1) That the ratio of the number of electrons per atom to the atomic weight is constant; the ratio being very nearly 3·0 for all the elements examined. (2) That the positive electricity within the atom is not in an electronic condition, but is distributed over the space occupied by the atom. Experiments are also described on the absorption of homogeneous β-rays [as in preceding Abstract]. It is shown that the first stage in the absorption of a pencil of homogeneous β-rays consists in the scattering of the rays according to the laws already considered. The absorption of the completely scattered radiation is then shown to take place according to an exponential law. E. M.

1608. *Relation between Uranium and Radium.* V. **F. Soddy.** (Phil. Mag. 20. pp. 340–342, Aug., 1910.)—In previous experiments [Abstract No. 84 (1910)] it was found that the rate of growth of Ra, in some old solutions of Ur was according to the square of the time and from the observations the existence of a long-lived intermediate parent (ionium) of Ra was deduced. Measurements made since these observations were published have not confirmed the rate of growth, and the author now withdraws the estimates and treats the results as affording data for the calculation of the minimum period of the supposed product. This minimum period is deduced to be 35,000 years. The author gives details as to how a maximum estimate of the period can be obtained. E. M.

1609. *Ratio between Uranium and Radium in Minerals.* **F. Soddy** and **R. Pirret.** (Phil. Mag. 20, pp. 345–349, Aug., 1910.)—Mlle. Gleditsch in an examination of the ratio of Ur to Ra in minerals found small but distinct variations in the ratio for Ceylon thorianite, Joachimsthal pitchblende, and French autunite [Abstracts 1282, 1552 (1909)]. The authors have repeated these experiments except that autunite of Portuguese origin was used. The Ra was determined in the usual way by observing the amount of RaEm generated in a solution of the mineral in a given time, without first separating out the Ra as was done in Mlle. Gleditsch's experiments. The ratios were found to

be practically the same for thorianite and pitchblende, while that for autunite was considerably less, being only 0·44 of that of pitchblende; whereas Mlle. Gleditsch found for French autunite the ratio 0·80. The authors explain these results by assuming that autunite is of so recent a formation that the Ur-Ra series is not yet in equilibrium, Portuguese autunite being more recent than the French. This former assumption is supported by the experiments of J. A. Gray [Ibid. 18, p. 287 (1909)], who showed that the percentage of lead in autunite was very low (0·005 per cent.) for a uranium mineral.
E. M.

1610. *Ratio between Uranium and Radium in Minerals.* **A. S. Russell.** (Nature, 84. pp. 238–239, Aug. 25, 1910.)—The author has determined the ratio of Ra to Ur in thorianite, pitchblende and autunite. [See also Gleditsch, Abstracts Nos. 1282, 1552 (1909).] He finds the ratio to be the same for thorianite from Java as for specimens of pitchblende from Joachimsthal and German East Africa, thus confirming the results of Soddy and Pirret [see preceding Abstract]. For autunite, however, from Autun (France) the ratio was found to be only 0·27 of that for pitchblende, compared with Soddy and Pirret's result of 0·44 for Portuguese autunite, and Mlle. Gleditsch's result of 0·80 for French autunite. To explain these results it must either be assumed that the Ra has been washed out of the mineral in some way, or that the mineral is so young that the Ur-Ra series is not yet in equilibrium. The author hopes to throw light on this matter by determining the ratios of uranium to ionium and actinium in different specimens, not only of autunite, but also of the family of minerals of which it is a member.
E. M.

REFERENCES.

1611. *Is Michelson's Experiment Established?* **M. Laue.** (Ann. d. Physik, 33. 1. pp. 186–191, Aug. 5, 1910.)—Defends Michelson's experiment against the criticism of E. Kohl [see Abstract No. 652 (1909)].
E. H. B.

1612. *The Ultra-rapid Kinematograph.* (La Nature, April 30, 1910. Nature, 84. pp. 112–113, July 28, 1910. Abstract.)—A description is given of the kinematograph designed by Bull and by means of which sharp stereoscopic kinematographic views may be obtained of such rapid movements as the flight of a fly or the breaking of a soap-bubble. The mean speed of the film is 4000 cm. per sec.
L. H. W.

1613. *The Physical Production of Light.* **E. P. Hyde.** (Frank. Inst., Journ. 169. pp. 439–466, June, and 170. pp. 26–45, July, 1910.)—The author considers briefly certain questions in physiological optics which determine the light-giving properties of radiant energy, and then discusses the laws of radiation and the radiating properties of metals. Attention is given to various new methods for determining selective radiation, and data obtained by these methods are furnished.

1614. *Radio-activity of the Mineral Springs of the Tyrol.* **M. Bamberger** and **K. Krüse.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 207–230, Feb., 1910.)—The results of the investigation (which includes spring and tap waters and the minerals and deposits in proximity to the former) are set forth almost wholly in the form of tables.
L. H. W.

1615. *Amount of Thorium in Sedimentary Rocks.* **J. Joly.** (Phil. Mag. 20. pp. 125–128, July, and pp. 353–357, Aug., 1910.)—[See Abstract No. 1411 (1909).]

HEAT.

1616. *Thermal Expansion of Metals.* **E. Grüneisen.** (Ann. d. Physik, 33. 1. pp. 33–64, Aug. 5, 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—The object of the research described was to extend our knowledge of the variations of the coefficient of expansion of metals with temperature, and hence establish a basis for the study of the relation between the coefficient of expansion and specific heat. The work of Holborn and Day, Henning, and Scheel and Heuse on the expansion of Pt is discussed at length with reference to the exponential formula of Thiesen [Abstract No. 1507 (1908)]. It is shown that this formula is very near indeed to the true law of expansion of metals, especially for low temperatures, the tests ranging to about −190° C. But whether one can extrapolate to the absolute zero, and whether the coefficient of expansion vanishes on nearing the absolute zero remains an open question. The exponent ϵ of Thiesen's formula, and so the variation of the coefficient of expansion with temperature, is shown to be a periodic function of the atomic weight, whose maxima occur at the minima of the expansion coefficients, and therefore about the minima of the atomic volumes. The total extension (calculated from Thiesen's formula) between the absolute zero and the melting-point is likewise a periodic function of the atomic weight, and hence is nearly the same only for a group of metals of nearly equal atomic weights; the extension increases with each group of higher atomic weights. Zn, Cd, and probably also Sn, are exceptions to this general rule, and their behaviour is perhaps due to discontinuity in the variation of their structure. A. W.

1617. *Peculiar Heat Phenomenon.* **F. R. Watson.** (Science, 32. pp. 251–252, Aug. 19, 1910.)—On carrying out the well-known experiment of passing steam through a mantle surrounding a barometer tube containing a small quantity of water, the author found that after a certain amount of depression of mercury had taken place, the latter began to oscillate about a point corresponding to the line of condensed steam in the mantle. During the oscillations the mercury continued to descend as the line of condensed steam descended. The author explains the phenomenon on the same basis as Griffiths explained the action of a hot-air engine. The mercury goes through a complete cycle during each oscillation, absorbing heat at steam temperature, and giving it out to the cold tube lower down. It becomes cooled also by the work it does in expanding. It is then pushed back up the tube from below, its pressure being less than when expanding because its temperature is less. Therefore more work is done during expansion than contraction. A. F.

1618. *Influence of Temperature and Pressure on the Coefficient of Expansion and the Specific Heat of Metals.* **E. Grüneisen.** (Ann. d. Physik, 33. 1. pp. 65–78, Aug. 5, 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—The author has previously shown that the ratio of the coefficient α of linear expansion of metals to the specific heat C_p is nearly independent of the temperature [Abstract No. 1114 (1908)]. This was established only for Al, Fe, Ni, Cu, Pd, Ag, Ir, and Pt, and not for other metals, especially such as have large atomic volumes. Further work is given in the present paper, and it appears that the ratio a/C_p varies slightly in many cases; sometimes a (as with Pb) and sometimes C_p (as with Sb and Bi) seems to increase more rapidly with the temperature. But within the limits of error the ratio is approximately the same for the range —190° C. to 17° C., and 17° C. to 100° C. for the metals dealt with. As regards the effect of pressure on the thermal expansion, it is shown that Thiesen's hypothesis [Abstract No. 1507 (1908)], that Θ is independent of the pressure, is better fulfilled the higher the melting-point of the metal. It also appears that the density and specific heat undergo for external pressure-changes, relative variations of the same order of magnitude. The decrease of the specific heat is smaller than the increase of density; the ratio of the two is about ¼ to ⅓. Schlett found, for Pt, the variation of the two to be about the same, while for Ni the change in C_p was about ¼ that of the density. A. W.

1619. *Statistical Theory of Radiation.* **J. Larmor.** (Phil. Mag. 20. pp. 350–358, Aug., 1910.)—The author controverts Wilson's criticism [see Abstract No. 1463 (1910)] of his theory that it does not evade the difficulty of an atomic constitution of energy. The entropy S was expressed in the form $k \log W$, where W is the number of ways in which the system can be arranged in the actual state. Wilson's criticism would be valid if k were independent of the scale adopted; k must, however, vary with the minuteness of subdivision. If the first part of the system contains n_1 elements of energy, each of amount ϵ_1, contained in N_1 cells, and similarly for the others, then it is $k\epsilon_1$ which remains constant when ϵ_1 is charged. The two independent constants are in fact $N_1\epsilon_1$ and $k\epsilon_1$, their ratio N_1/k being the gas-constant. The only other predetermined quantity is $N_1\epsilon_1 = a$ say, the ratio of the energy element to the extent of a cell. That there must exist a second constant corresponding to a follows from the fact pointed out by Wien and Thiesen that the value $\lambda_m T$, where λ_m is the wave-length of max. radiation at temperature T, and which is by Wien's law a universal constant, suffices, and is required, in conjunction with the other recognised and universal constants of nature, to establish an absolute system of fundamental units of mass, length, and time; its dimensions are therefore not expressible in terms of those of other universal constants, and it must have an independent existence of its own. G. W. de T.

1620. *Thermodynamic Calculation of the Vapour Pressure of Water and Ice.* **W. Nernst.** (Deutsch. Phys. Gesell., Verh. 12. 14. pp. 565–571, July 30, 1910.)—[See Abstracts Nos. 1717 (1909) and 1116 (1910).] The author used the results obtained by himself and Levy to calculate the constants in a modified Clausius-Clapeyron equation—

$$\lambda' = (\lambda'_0 - aT)(1 - v_0/v')$$

$$\log p' = -\lambda_0/4571T - a/1{\cdot}985 \log T + J.$$

For liquid water, employing the vapour pressure measured at 0°, 50°, 100° C., the values obtained for the constants were: $\lambda' = 18512$, $a = 10{,}080$, $J = 23{\cdot}86774$. For the vapour pressure of ice, where $T = 273{\cdot}09$ and vapour pressure 4·579 mm., the latent heat of vaporisation is $\lambda = 10756 + 18{\cdot}014 \times 79{\cdot}7 = 12192$ since at low pressures water-vapour almost exactly obeys the gas laws. F. J. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1621. *Dissipation of Atmospheric Electricity in the Immediate Neighbourhood of the Ground.* **H. Ebert and K. Kurz.** (Kgl. Bayer. Akad. d. Wiss. 25. 2. 1909. Phys. Zeitschr. 11. pp. 389–405, May 1, 1910. Extract.)—[See also Abstracts Nos. 2290 and 3246 (1904).] The work of Elster and Geitel is referred to by the author, as also the practical proposal for registering the variations due to A. Sprung and Lüdeling. The method of working and instruments used by the authors are next dealt with. A layer of sand covering the "earth" was frequently employed, and the results compared when this was present and when absent. The observations are naturally divided into two periods—one (the summer period) April 23–Aug. 17, 1908, the other (winter) Dec. 16, 1908–March 8, 1909. The difference in the number of ions formed per sec. in the open air and that in holes and cellars is noted, and the influence of emanations discussed. In the discussion of the results 975 hourly registrations of positive ions and 1250 of negative are employed; of these 1859 were made on the ground (gravel soil only); in the remaining 366 the soil was covered with sand. The latter everywhere caused a slight increase in the values obtained, though for all cases there is an excess of the positive over the negative ions; this is greater for the sand-covered soil than when the latter is in its natural condition. Curves showing the mean daily march of E_+, E_-, $Q = E_+ - E_-$ and $q = E_+/E_-$ are given for both the summer and the winter series. The curves for the positive ions show 2 daily maxima and 2 daily minima for the former, the times of maxima being 3–4 a.m., 3–4 p.m.; for minima, 6–7 a.m., 6–7 p.m.; each maximum being followed 3 hours later by a minimum, but 9 hours is required from this to the next maximum. The daily curves for the negative ions show greater variations, though the absolute values are smaller, and the times of maxima (11–12, 7–8 p.m.) and minima (6–7 a.m., 4–5 p.m.) are quite different. The winter series, as compared with the summer one, shows the much smaller amplitude of the variations. Both the positive and negative curves show only one daily maximum and minimum, by no means well-defined. Comparison of these results with the height and variation of the barometer, already considered by Mache, follows, and the authors give curves showing graphically the results of this, for the positive and negative ionisation respectively. From these it is seen how direct is the connection between variations in atmospheric pressure and ionisation. The curve of ionisation is almost the image of that giving the variations in air pressure, the maxima of the one corresponding to minima of the other, and *vice versâ*, but following at about 1¼ hours' interval of time; so that we may almost regard those variations (of pressure) as the cause of the variation in the ions. F. W. H.

DISCHARGE AND OSCILLATIONS.

1622. *Ionisation produced by the Splashing of Mercury.* **J. J. Lonsdale.** (Phil. Mag. 20. pp. 464–474, Sept., 1910.)—Special precautions are taken to ensure that the ionisation measured is actually produced by the splashing and the apparatus used for this purpose is fully described. As a result of the experiments it is found that splashing mercury on an iron plate produces a large excess of positive ions, and that a considerable proportion of these ions have a very small velocity. The amount of ionisation depends on the nature of the surface on which the splashing is produced. The current-voltage curves for the positive ions show peculiarities which may be easily explained by supposing that neutral doublets are present and that these are broken up by the field or other means. When the drop is below a certain height these doublets are apparently not produced. Similar peculiarities are also noticed in the saturation curves for positive ions from aluminium phosphate and lime [see also Abstract No. 845 (1910)]. The negative ions from these three sources show no such peculiarities. A. E. G.

1623. *Velocity of Electrons generated by Soft Röntgen Rays.* **W. Seitz.** (Phys. Zeitschr. 11. pp. 705–708, Aug. 15, 1910.)—When Röntgen rays strike a metal electrons are set free, and these electrons possess very different velocities. Their max. velocity increases according to Bestelmeyer, Innes, and also Laub [Abstracts Nos. 1070, 1670 (1907), 1625 (1908)] with the hardness of the generating rays, the measurements in these cases being made by means of tubes using discharge potentials of the order 85,000 volts. In the present experiments discharge potentials of less than 10,000 volts are employed, and the method of making the measurements is essentially the same as that used by Laub. As the result of the experiments it is concluded that by far the greater part of the electrons possess only an extremely small fraction of the max. velocity, and this max. velocity is probably equal to that of the kathode rays which are generated by the Röntgen rays. A. E. G.

1624. *New Arrangement for Separation of Alternating Electric Discharges.* **U. Magini.** (Atti dell' Assoc. Elettr. Ital. 14. pp. 489–494, July–Aug., 1910.)—A method of obtaining a strictly unidirectional current in a Röntgen-ray tube from a transformer or induction coil is described. Spinterometers are employed which consist of a flat, or, in later forms, a cup-shaped terminal and for the other terminal an Al rod ending in a point situated inside the cup or opposite the plate. Three such spinterometers are used, one being connected across the secondary terminals in such a direction that the current that is not wanted in the Röntgen tube will pass; the other two being in circuit in parallel with the first, but having a direction such that the current required in the tube will pass. The Röntgen tube itself is placed in this second circuit in series with the two spinterometers and situated between them. Thus only one of the discharge currents passes through the tube, the other passing through the first spinterometer. The apparatus is simple and is attached to the secondary terminals only, thus leaving the primary circuit undisturbed. This is an advantage over the previous methods of obtaining a similar result, and the effectiveness is illustrated by reproductions of several radiographs of objects having a delicate bone structure. S. G. S.

1625. *Electrode Material and Light- and Heat-emission of Spark.* **H. R. v. Traubenberg.** (Acad. Sci. St. Pétersbourg, Bull. 12. pp. 891–914, Sept. 12, 1910.)—Various metals are used as electrodes of the spark-gap in an oscillatory circuit and the spark-damping and the heat- and light-emission of the spark measured; the damping being determined by the usual Bjerknes method. The following series gives the metals arranged in the order of increasing damping: Na, Bi, Ur, Mg, Pb, Tl, Sn, Sb, Cd, Ag, Al, Zn, Fe, Cu. The light and heat radiation is investigated by a thermopile, an alum-solution filter being used in one case and a rock-salt filter in the other. For light, in the order of decreasing intensity, the following is the series: Ur, Na, Mg, Sn, Pb, Fe, Cu, Zn, Ag, Al; for heat: Ur, Bi, Fe, Cu. The spark-spectra are also investigated and discussed. T. P. B.

1626. *Transmission of Waves by a Grating.* **H. Lamb and G. Cook.** (Phil. Mag. 20. pp. 303–309, Aug., 1910.)—The authors point out that the transmission of Hertzian waves by a grating has been studied experimentally and compared with theory by Schaefer and Laugwitz and by G. H. Thomson [see Abstracts Nos. 119, 698 (1907)]. The formulæ expressing the theory of scattering of aerial and electrical waves by a grating are, however, identical with those expressing the wave modification due to one or more cylindrical obstacles with vertical generating lines disposed symmetrically near the centre of a long, narrow rectangular tank containing water in longitudinal oscillation. Cases were selected in which the effect of the obstacles in altering the period of the gravest mode of oscillation could be calculated, and the results compared with those obtained by observation, with various depths of water in the tank. The observed results were found to agree very closely with the calculated ones. G. W. DE T.

1627. *Short-wave Electric Spectrum.* **H. Merczyng.** (Acad. Sci. Cracovie, Bull. 4a. pp. 101–115, April, 1910. Ann. d. Physik, 33. 1. pp. 1–16, Aug. 5, 1910.)—Short electric waves were produced by a Righi oscillator and a parallel beam thrown on to the clean surface of various liquids including mercury. The reflected beam was received by a parabolic mirror and focussed on to a thermo-couple connected to a Rubens galvanometer. The electric vibrations were always perpendicular to the plane of incidence on the reflecting surface. The ratio of the intensity of the reflected beam to that of the incident one is a known function of the index of refraction *n*, whence it and its square, which is the dielectric constant, are both calculable. The short electric waves used had a length of 4·5 cm. in air. Longer electric waves were also used to afford a comparison. The chief results are shown in the table.

Substance.	Index of Refraction *n* for λ = 4·5 cm.	Dielectric Constants D = n^2 for—		
		λ = 4·5 cm.	Long Waves.	Light.
Aniline	2·09	4·36	7·4 (nearly)	2·5
Glycerine ($C_3H_8O_3$)	40·9	16·8	56	2·1
Methyl alcohol (CH_4O)	5·48	29·4	32–33	1·8
Amyl alcohol ($C_5H_{12}O$)	1·82	8·31	16 (nearly)	1·9
Acetic Acid ($C_2H_4O_2$)	1·87	3·5	9·7	1·9
Ethyl ether ($C_4H_{10}O$)	1·81	3·26	4·25	1·9

E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1628. *Investigation of Non-vibratory Types of Frequency Meters.* **C. E. Hiatt.** (Phys. Rev. 31. pp. 68–76, July, 1910.)—The author first gives an account of experiments with a form of Fleming alternating-current galvanometer; these show that its sensibility is high only for low frequencies. He then reverts to his frequency meter based upon the heating up of a thin iron wire subjected to an alternating magnetic field [see Abstract No. 148 (1910)]. In the present instance the heating is not measured by thermo-couple, but instead a bolometric arrangement in bridge form is adopted. The four arms of the bridge are each composed of a length of thin (0·0518 mm. diam.) iron wire, wound on a mica frame. Two such frames are enclosed in a solenoid; the other two are placed within a similar solenoid which is non-inductively wound. The one pair of arms only will therefore get heated up on the passage of current through the solenoids in series; the current in the coils is kept constant to within 0·2 per cent. by a special arrangement. Curves are given which show that for frequencies from 850 to 1400 ∿ per sec. the deflections when plotted form a straight line. It is considered likely that a single instrument can be made which will be able to measure frequencies of from 10 to 10^6 ∿ per sec. L. H. W.

1629. *Radio-active "Decadometer."* **C. Ramsauer.** (Le Radium, 7. p. 223, Aug., 1910. Paper read before the Congrès Internat. de Radiologie, Brussels, Sept., 1910.)—The paper deals with an apparatus for the convenient investigation of decaying radio-active bodies. The active substance produces ionisation in a cylindrical chamber whose walls are connected to a battery and whose central electrode is connected to an electrode in another chamber in which ionisation is produced by a constant radio-active source. Thus the ionisation produced by the decaying substance causes the electrodes to charge up to a potential indicated by a sensitive electrometer connected to them, equilibrium being obtained when the loss of charge from one electrode is equal to the gain of charge at the other. The electrometer needle follows the decay of the active substance with little lag, and the potential indicated is practically proportional to the activity. E. M.

1630. *Emanometer for Measuring Radio-active Emanations.* **A. Becker.** (Le Radium, 7. pp. 222–223, Aug., 1910. Paper read before the Congrès Internat. de Radiologie, Brussels, Sept., 1910. Zeitschr. Instrumentenk. 30. pp. 293–302, Oct., 1910.)—The author has devised an instrument for measuring the emanation given off by a given solution. The liquid under investigation is placed in a vessel where it is allowed to accumulate its equivalent amount of emanation. This is then passed at a known speed through a cylindrical condenser whose central electrode is connected to an electrometer. The electrometer is previously charged, and the total fall of potential caused by the passage of the emanation gives a measure of the amount of emanation. It is found that the apparatus works simply and well in practice, and owing to the ease with which experimental conditions can be reproduced, the author proposes to establish a definite unit of emanation based on it. Particulars are given in the paper of this unit which has been made equal to that of Mache. E. M.

1631. *New Form of Capillary Electrometer.* **L. Zehnder.** (Zeitschr. Instrumentenk. 30. pp. 274–278, Sept., 1910.)—Description of a capillary electrometer in which, by means of a movable reservoir of mercury, as in the air thermometer, the mercury in the capillary may be brought to the same point with or without an e.m.f. applied to the instrument. The mercury of the pressure apparatus is separated from that in the electrometer by an inverted U-tube filled with air. There is a stopcock on the stem above the capillary, and the capillary itself is a separate piece connected to the stem by means of a ground joint. The capillary can thus be renewed without dismantling the whole instrument. G. E. A.

1632. *New Form of Magnetic Detector of Electric Oscillations.* **R. Arnò.** (Accad. Lincei, Atti, 19. pp. 805–809, June 16, 1910.)—The author in the present case makes use of Borel's arrangement for producing a rotating magnetic field [Brit. Pat. 1388 of 1888], there being two identical solenoids—placed at right angles to one another and symmetrical with respect to a rotatable metal (silver) cylinder—each provided with an iron core and supplied from the same a.c. source. Normally things are so adjusted that there is no deflection (torque on the cylinder), by regulation of the distance of one of the cores. Fessenden's idea of producing a displacement of the magnetic flux by causing the oscillations to act upon the core itself, in place of upon the cylinder, is applied, a secondary winding being provided on one of the cores for this purpose. No details are given. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1633. *Temperature Coefficients of the Ferromagnetic Metals.* **J. R. Ashworth.** (Nature, 84. p. 238, Aug. 25, 1910.)—For temperatures up to 100° C., the coefficient is large in Ni, less in Fe, and least in Co. Carrying the temperature to 300°–400°, and plotting the magnetic intensity in the cyclic state against a scale in which temperatures are calculated as percentages of the critical temperatures, the points are all found to lie very nearly on one curve. Taking advantage of Curie's observations on the critical temperature, it is concluded that the coefficient of expansion of all magnets at corresponding temperatures is the same, also that the temperature coefficient of density of liquids is of the same order as the temperature coefficient of intensity of paramagnetics. G. E. A.

1634. *Variation of Specific Susceptibility with Temperature.* **K. Honda.** (Comptes Rendus, 151. pp. 511–513, Aug. 29, 1910.)—The author's experiments lead to a law somewhat different to Curie's, viz.: The effect of an increase of temperature on the specific susceptibility of an element is equivalent to that of a small increase in its atomic weight. The exceptions to this are few, phosphorus and copper being the most important. A. D. R.

1635. *Heusler Magnetic Alloys.* **E. B. Stephenson.** (Phys. Rev. 31. pp. 252–260, Sept., 1910.)—Magnetic tests were carried out on six Cu-Mn-Al alloys of varying composition. The following are the chief results: (1) The most magnetic specimens were those with Mn and Al in atomic proportions. (2) Heating to various temperatures, cooling in air, and testing at room temperature, gave for H = 50 a permeability-temperature curve with a slight minimum at 250°, a slight maximum at 350°, a decided minimum at 650°, and a rise to better than the original value at 900°. (3) The largest value of induction was obtained with a specimen which had been quenched in water from near its melting-point. (4) The tests suggest the existence of a practically non-magnetic allotropic form of the alloy. (5) No relation was found between magnetic properties and crystalline structure although the latter varied with the thermal treatment. A. D. R.

1636. *Novel Phenomenon in Diurnal Inequality of Terrestrial Magnetism.* **R. B. Sangster.** (Roy. Soc., Proc. Ser. A. 83. pp. 428–431, March 22, 1910.)—The author deals with the diurnal inequality at Greenwich, Falmouth, and Pawlowsk (Russia) for several periods from 1878 to 1907. Diagrams are given of the diurnal variations of magnetic force in the plane of the astronomical meridian; these show that there is little or no variation of the component parallel to the earth's axis during the hours from noon to about 5 p.m. There is, however, large simultaneous inequality of the component perpendicular to the earth's axis. The winter months invariably showed a shorter duration of the phenomenon, while in general a larger diurnal range produced a more exact and lengthened exhibition. L. H. W.

REFERENCES.

1637. *Inertia of Moving Electron.* **E. Hupka.** (Ann. d. Physik, 33. 2. pp. 400–402, Aug. 30, 1910.) **W. Heil.** (Ibid. pp. 403–418, Aug. 30, 1910.)—A discussion as to a previous experiment by Hupka and its interpretation. [See Abstract No. 619 (1910).] E. H. B.

1638. *Theory of Electrons in Metals.* **P. Debye.** (Ann. d. Physik, 33. 3. pp. 441–489, Sept. 22, 1910.)—An elaborate investigation, largely mathematical, and concluding with a comparison with experiment and conjectures on the discrepancies found to occur. E. H. B.

1639. *Electron Theory of Thermo-electricity.* **K. Baedecker.** (Phys. Zeitschr, 11. pp. 809–811, Sept. 15, 1910.)

1640. *Variable Motions of Electricity without Magnetic Field or Radiation Field.* **P. Ehrenfest.** (Phys. Zeitschr. 11. pp. 708–709, Aug. 15, 1910.)—The motion in question is the radial pulsation of electricity in a spherical shell, so distributed that its density is a function of distance from centre only, and moving so that at each instant the distribution and radial velocities have spherical symmetry. E. H. B.

1641. *Mercury Interrupters with Compressed Gas Dielectric.* **E. B. Hazleton.** (Röntgen Soc., Journ. 6. pp. 119–120, Oct., 1910.)—Description, with illustration, of a completely enclosed interrupter which works under a gas pressure of 15 lbs. per sq. in. L. H. W.

1642. *Photographic Action of the Positive "Brush" Discharge.* **C. W. Raffety.** (Röntgen Soc., Journ. 6. pp. 115–119, Oct., 1910.)

1643. *Electric Conduction in Dense Gases.* **R. Seeliger.** (Ann. d. Physik, 33. 2. pp. 319–380, Aug. 30, 1910. Extract from Dissertation, Munich.)—A theoretical discussion in which the problem is made to depend on the solution of a differential equation of the first order whose qualitative discussion gives a preliminary view of the mathematical and physical questions involved. A quantitative treatment of the field and the characteristic is then carried out by numerical quadrature or series expansion. For very weak and very strong currents approximate formulæ are obtained. The saturation current is also specially dealt with. E. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1644. *Metallic Radium.* **Mme. P. Curie and A. Debierne.** (Comptes Rendus, 151. pp. 523–525, Sept. 5, 1910. Chem. News, 102. p. 175, Oct. 7, 1910.)—The authors have obtained metallic Ra by a method similar to that employed by Guntz for the preparation of metallic Ba. A solution of 0·1 gm. of pure $RaCl_2$ was electrolysed, using a mercury kathode of weight about 10 gm. The Ra amalgam formed was found to decompose water and to alter rapidly in air; it was entirely liquid, although under the same conditions an amalgam of Ba contains numerous crystals. The distillation of the amalgam was made in a small iron boat in a quartz tube with an atmosphere of specially purified hydrogen. The greater part of the mercury was distilled at 270° C.; then the temperature was increased gradually and the amalgam became solid at about 400° C., but melted at a higher temperature and the mercury was given off. At 700° C. the mercury had ceased to come off and the metal commenced to volatilise, the vapour attacking the quartz tube energetically. The distillation was then stopped, the authors concluding that the remaining substance, which had a shining, white metallic appearance was practically pure Ra. The metal was found to blacken rapidly in air, probably forming a nitride. A detached piece was placed in water and the greater part dissolved in decomposing the water. The insoluble remainder was black, and nearly all went into solution on the addition of a little HCl, being probably the nitride formed by exposure to the air. The very small amount of final residue showed that very little mercury was present. The small iron boat, to which most of the metal adhered, was sealed up *in vacuo* for the observation of its radio-active properties. γ-Ray measurements showed that the activity increased according to the law of production of emanation. The authors hope to make use of the greater volatility of Ra than Ba for the purification of the former. E. M.

1645. *Metallic Strontium.* **B. L. Glascock.** (Amer. Chem. Soc., Journ. 32. pp. 1222–1230, Oct., 1910. Chem. News, 108. pp, 236–239, Nov. 11, 1910.)—A description is given of a large number of experiments made to prepare strontium by electrolysis of the fused chloride, using furnaces of different types and modifying them in the directions indicated by the results of each experiment. The most successful results were obtained as follows: A cast-iron vessel of hemispherical shape, 25 cm. in diam. and walls 0·6 cm. in thickness, served as a container for the fused strontium chloride. To keep the liberated metal from contact with the air, and also to carry out Stockem and Borchers' idea of a small kathode, an iron rod 1·8 cm. in diam., bent at right angles about 2 in. from its lower end, which was then hammered to a blunt point, was made to serve as the kathode. The anode was of carbon, 8 cm. × 8 cm. By this arrangement the current was made to pass entirely beneath the surface of the bath, since the vessel was deep enough to prevent the current passing to it and thence to the other electrode. A porous plate could be interposed between the electrodes. With an electrolyte of pure strontium chloride and a current of 125 amps. at 40 volts for 7 hours, 76 gm. of metallic Sr were obtained, giving a current efficiency of 5·8 per cent. Passing the current for longer than 6–8 hours decreased the actual yield, the best percentage yield being when a current of 135 amps. and 35 volts was passed for only 2 hours, the current efficiency then being 6·7 per cent. The metallic Sr is distributed in globules throughout the fusion, and is best separated from the cold mass by crushing it on an iron plate and then sieving out the metal. It cannot be obtained as a rod by gradually raising the kathode during electrolysis, as is the case with calcium. Strontium possesses a silver lustre when a new surface is first exposed; this, however, rapidly changes to a yellowish tint, and finally to a white non-lustrous surface as the layer of oxide forms over it. It is harder than Na but softer than Ca, and can easily be cut with a knife. Its density is 2·55. It liberates hydrogen readily from water and alcohol, but has no action on silicon tetrachloride. It alloys with iron and seems to combine with chromium and amorphous boron when heated with them. It dissolves in liquid ammonia to a blue solution, and burns in an atmosphere of CO_2 and illuminating gas as energetically as it does in air. The heated metal combines with hydrogen and nitrogen, forming the hydride and nitride respectively. The specific heat is 0·0742, which gives 6·5 for the atomic heat. The alloy with iron slowly evolves hydrogen when put into water. In the account of the preliminary experiments a furnace is described by means of which Ca was readily obtained. It consisted of blocks of Acheson graphite, which were so built together that they formed the container for the fused calcium chloride, and at the same time formed the anode. The kathode was an iron rod, 2 cm. in diam. With 80 amps. at 40–50 volts 300 gm. of calcium were easily obtained in 6–8 hours.

T. S. P.

1646. *Colour developed by Crystallisation of Colourless Solutions of Coloured Substances.* **D. Gernez.** (Comptes Rendus, 151. pp. 272–276, July 25, 1910.)—Mercuric iodide separates from organic solvents even at low temperatures in the yellow form; this gradually changes into the red form which is the more stable at all temperatures up to 120°. Formanilide, salol, menthol, thymol, and benzophenone give colourless supersaturated solutions which solidify (when inoculated with a crystal of the solid) at the rate of a few mm. only per min., becoming yellow as the mercuric iodide is thrown out by the crystallisation of the solvent, and subsequently changing to red as the iodide passes over into its more stable form.

T. M. L.

1647. *Conductivity of Concentrated Aqueous Solutions at 0° C.* **W. H. Sloan.** (Amer. Chem. Soc., Journ. 32. pp. 946–949, Aug., 1910.)—Franklin has shown that some salts when dissolved in ammonia and in methylamine give maximum values for the equivalent conductivity at intermediate as well as at very high dilutions. The same phenomenon is indicated by the following figures for potassium iodide in water at 0°:—

Dilution......	ϕ/1000	0·1766	0·1845	0·2075	0·2371	0·2760	0·2767	
Conductivity	Λ	57·3	59·2	64·3	65·2	67·8	67·7	
	0·3320	0·4150	0·5534	0·664	0·830	1·328	1·660	
	69·3	70·4	70·8	70·4	70·6	70·5	70·7	
			Max. (?)			Min. (?)		
	2·651	3·32	4·15	5·31	7·81	10·62	13·28	21·28
	70·8	71·6	72·0	72·4	73·1	74·1	74·6	75·8

The maximum and minimum are here reduced to little more than an arrest or inflection in the curve, but there can be no doubt that precisely similar causes are at work in the case of the aqueous and the ammoniacal solutions. The curve for potassium bromide tends towards the same type although there is no actual maximum or minimum at intermediate dilutions. T. M. L.

1648. *Simple Practical Experiments on Solution-velocity.* **W. A. Roth.** (Zeitschr. Elektrochem. 16. pp. 714–716, Sept. 1, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The rates at which carbonic anhydride and lead sulphate dissolve in water can be studied by noting in the former case the rise of temperature which accompanies the dissolution of the gas, and in the latter case the increase in the electrical conductivity of the solution. By making use of these two methods it is shown that each action conforms accurately to the unimolecular law, although the constant varies very greatly when the experimental conditions are altered. T. M. L.

1649. *Gas Generation in Lead Accumulators and their Capacity.* **F. Streintz.** (Zeitschr. Elektrochem. 16. pp. 747–754, Sept. 15, 1910. Paper read before the Deutsch. Bunsen-Gesell., Giessen, May, 1910.)—The experiments were, like those of Rumpf [see Abstract No. 687 (1910)], to whom the author refers, made with small Varta cells, arranged as voltameters; but he added a lead peroxide electrode as reference electrode. The gas generation during formation was also studied. The charging currents ranged from 0·1 down to 0·0009 amp.; the discharge was as a rule at 0·2 amp. This latter rate could be kept up for 4 hours; then the current decreased, owing chiefly to the exhaustion of the positive plate, when the directions of the makers were followed. The hydrogen absorption by the negative plate during the charge is inversely proportional to the current intensity; this does not hold for very small intensities, since the negative plate loses gas on open circuit. As regards the positive plate, a simple relation between current intensity, time, and oxygen absorption could not be found. The author distinguishes between an ordinary and an extraordinary type of discharge. In the former the discharge is continued till the negative electrode is exhausted, in the latter till the positive plate is exhausted; in the latter type either the positive electrode proved to be insufficiently formed, or the negative had occluded large amounts of hydrogen. H. B.

1650. *Potential and Electric Conductivity of Aluminium-Calcium Alloys.* **J. M. Breckenridge.** (Amer. Electrochem. Soc., Trans. 17. pp. 367–375, 1910.)—Aluminium is fused under $CaCl_2$, calcium added, and the alloy poured into an iron mould, completely filling the mould and mouthpiece. The electrolyte is especially purified ethyl alcohol, and contamination of this solution by the aqueous calomel solution of the normal electrode is prevented by inserting plugs of filter-paper in the connecting glass tube. Fine copper wire is wound round the alloy to secure good contact. The potential fluctuates a good deal at first. It rises with increasing Ca-percentage, suddenly for about 88 per cent. of Ca. The conductivity decreases with increasing Ca-percentage, and the conductivity curves likewise indicate the existence of the alloy Al_2Ca. H. B.

1651. *Conductivity and Electrolysis of Cuprous Chloride Solutions.* **M. de K. Thompson** and **E. R. Hamilton.** (Amer. Electrochem. Soc., Trans. 17. pp. 287–294, 1910.)—Preliminary account of some incomplete, but interrupted experiments. The chloride Cu_2Cl_2 ought to give twice as much Cu per coulomb as $CuSO_4$. The Cu_2Cl_2 is hardly soluble in water, but soluble in NaCl; the conductivity of the NaCl (15 to 30 per cent. solutions) decreases on adding Cu_2Cl_2 to it, but this can be prevented by acidifying with HCl, which also clears the turbid solution. The electrolysis of the solution (covered with paraffin) gave up to 96 per cent. of the possible yield (100 standing for twice the amount of Cu deposited in the $CuSO_4$ voltameter); but the anodes were corroded at the surface where trees formed, as observed by Cohen and Lenz in 1898, unless good stirring was applied. A tendency to oxidation was also noticed. H. B.

1652. *Electrolysing Fused Matte.* **E. M. Chance.** (Amer. Electrochem. Soc., Trans. 17. pp. 285–288, 1910.)—The author fuses matte, from pyrites, *e.g.*, in a small fire-clay crucible, placed in a gas furnace, covers the matte with sodium metasilicate as electrolyte, introduces a copper wire as anode through the bottom of the crucible, and a carbon or steel rod as kathode from above, and electrolyses with a battery of four accumulator cells. Pure Cu is deposited, at higher e.m.f. an alloy of Cu and Fe, while the sulphur is volatilised. Nickel-copper matte was similarly treated with success; Sb volatilised like sulphur. The e.m.f. must not be allowed to decompose the silicate. Chlorides, as substitute for the metasilicate, did not answer; sodium chloride was useful, however, with Pb-Ag alloys of low melting-point. Experiments on a larger scale are not mentioned. H. B.

1653. *Electrolytic Preparation of Magnesium.* **S. A. Tucker** and **F. L. Jouard.** (Amer. Electrochem. Soc., Trans. 17. pp. 249–260, 1910.)—Molten $MgCl_2$ can be electrolysed in the presence of KCl preferably in a carbon or graphite crucible; but the bath is troublesome and expensive to prepare; the current efficiency comes up to 60 per cent. The presence of MgO is to be avoided; a small proportion of CaF_2 tends to consolidate the metal. Changes of current density and temperature, if not large, have little effect. Baths of MgF_2 with LiF, and CaF_2 gave little or no Mg; the Mg is dissolved by this bath, which also attacks iron crucibles. The proposal of F. v. Kügelgen and G. O. Seward—to bind Mg by an Al-kathode in a chloride bath and to electrolyse the resulting crystalline alloy as anode in a bath of greater density in which the Mg would rise to the surface—is not recommended; the efficiency was not raised by binding the Mg by Al or Cu, and the electrolytic decomposition of the Al-Mg failed. H. B.

1654. *Electro-deposition of Platinum.* II. **W. J. McCaughey** and **H. E. Patten.** (Amer. Electrochem. Soc., Trans. 17. pp. 275–285, 1910.)—The authors have studied the electrolysis of the following aqueous solutions: (1) 10 per cent. citric acid; (2) 2 per cent. potassium platinichloride; (3) 2 per cent. ammonium platinichloride; (4) 2 per cent. potassium platinichloride containing 10 per cent. citric acid; (5) 2 per cent. ammonium platinichloride containing 10 per cent. citric acid. The single potentials, at anode and kathode during electrolysis of the above solutions were measured by momentarily interrupting the current and balancing the e.m.f. of discharge-potential plus an Ostwald tenth-normal electrode against a known e.m.f., using a d'Arsonval galvanometer as zero instrument. A Pt dish served as the kathode, and permitted the deposit to be weighed; the anode was of polished Pt, 10 cm.² in area. The solution was heated to 75–80° C. before electrolysis, and then electrolysed, no attempt being made to maintain its temperature. The results show that the presence of citric acid does not give a lower

V.1
191

kathode potential than that which obtains while Pt is depositing in the absence of citric acid. The function of the citric acid appears to be to maintain the solution acid. An alkaline solution furthers the formation of a fine cloud of Pt, which may be thrown out of suspension upon the kathode, and the particles then serve as nuclei for the deposition of large crystals. The reduction of citric acid to aldehyde may further influence the form of the deposit. The cloud of fine Pt does not form immediately in a *fresh* solution of potassium or ammonium platinichloride, unless the current density be too high. If a platinichloride solution which has been electrolysed be regenerated by addition of solid platinichloride and again subjected to electrolysis, the cloud of fine Pt is soon formed and the deposit is poor, but if a drop or two of concentrated hydrochloric acid be added to 100 c.cm. of solution the cloud formation is delayed and a good deposit is formed. Mineral acid is objectionable, however, because it attacks the underlying metal, and the deposit of Pt is liable to become crystalline before a satisfactory coating can be obtained. When, however, citric acid is used, the plating solution may be regenerated many times by the addition of platinichloride without cloud formation, and good deposits of Pt obtained. Even in the solution containing citric acid the deposit of Pt becomes poor after some 25 to 30 min. of electrolysis. In practice, a good thick deposit of the metal is obtainable by repeatedly plating for 10 min. periods. After each treatment the deposited metal is dried and buffed. The solution is regenerated by adding potassium platinichloride before each treatment, and will serve for some 20 to 30 treatments, after which it may be further regenerated by adding about 10 drops of concentrated HCl; it will then serve for 5 or 6 more deposits of Pt. [See Abstract No. 1978 (1909).]

T. S. P.

1655. *Electrolytic Reduction of Nitric Acid.* III. **H. E. Patten and W. J. McCaughey.** (Amer. Electrochem. Soc., Trans. 17. pp. 377–390, 1910.)—The reduction of hydroxylamine to ammonia at a copper kathode in the presence of copper sulphate, sulphuric acid, and hydrochloric acid has been investigated. Nitrogen is liberated at both anode and kathode. The rate of this liberation has been studied quantitatively. Nitrogen is evolved at the anode at a fairly constant rate, ammonia being left in solution; at the kathode nitrogen is set free rapidly at first, and in such quantity as to suggest the possibility of the formation of hydrazine as an intermediate product, and its subsequent oxidation by hydroxylamine, thus producing free nitrogen. As electrolysis proceeds the formation of nitrogen gas decreases. This initial evolution of free nitrogen in quantity is also met in the electrolytic reduction of nitrate under the same conditions, and suggests that the hydroxylamine formed in the reduction of the nitrate may in that case also be reduced to a lower stage of oxidation, such as hydrazine. Single potential discharge measurements from kathode and anode are also given. [See Abstract No. 1978 (1909).]

T. S. P.

1656. *Electro-deposition of Lead from Perchlorate Baths.* **F. C. Mathers.** (Amer. Electrochem. Soc., Trans. 17. pp. 261–272; Discussion, pp. 272-278, 1910.)—Experiments with the lead perchlorate plating and refining bath are described. The properties of lead perchlorate which are of special value in plating or refining solutions are: (1) Great solubility. (2) Kathode deposits which are smooth, dense, and free from "trees." (3) Approximately theoretical corrosion of the anode and deposition upon the kathode. (4) Absolute stability under all conditions to which it is subjected in a plating or refining bath. (5) No polarisation from the formation of lead peroxide on the anode. (6) Very high electrical conductivity. The bath should contain about 5 per cent. of lead, 3–5 per cent. of free perchloric acid, and 0·25 per cent. of peptone. A current density of from 2–3 amps./dm.^{2} (18–27 amps. per sq. ft.) may be used. The peptone is gradually used up, and after about 4 days a quantity equal to the original amount should be added. The free acid, which is very slowly neutralised by chemical solution of the lead, must be restored by treatment of a suitable portion of the solution with the right amount of sulphuric acid, which precipitates lead sulphate and leaves perchloric acid in solution. The filtrate is returned to the bath. The bath gives excellent purification, the kathode being about 99·98 per cent. pure. The deposit is smooth, coherent, and has a density of 11·36. As a plating bath, the lead perchlorate solution works exceptionally well on account of the absence of "trees" or of loose crystals on the edges, even when the deposits reach a thickness of 1 in. The bath shows no deterioration with use, and gives as good deposits after 2 months as at the beginning, if the concentration, acidity, and the required amount of peptone are maintained. Chloride and barium salts must be absent. A bath that has been giving good deposits will form very bad "trees" if a quantity of hydrochloric acid or some barium perchlorate is added to it. [See Abstract No. 1316 (1909).] T. S. P.

REFERENCES.

1657. *Influence of Mass Distribution in the Molecule upon Magnitude of the Molecular Forces.* **E. Bose** and **M. Bose.** (Zeitschr. Phys. Chem. 69. pp. 52–68, 1909.)—A theoretical paper in which the advantages are pointed out of the view that the molecular forces are regarded as not being exerted from the centre of mass of the molecules, but localised in the separate parts of the molecule. L. H. W.

1658. *Preparation of a Solution of Colloidal Selenium.* **A. Pochettino.** (N. Cimento, 19. pp. 335–344, May, 1910.)

1659. *Liberation of Helium from Minerals by the Action of Heat.* **D. O. Wood.** (Roy. Soc., Proc. Ser. A. 84. pp. 70–78, June 9, 1910.)

1660. *Formation of Nitric Oxide in the Combustion of Carbon Monoxide.* **F. Haber** and **J. E. Coates.** (Zeitschr. Phys. Chem. 69. pp. 337–388, 1909.)

1661. *Action between Metals and Acids and Conditions under which Mercury causes Evolution of Hydrogen.* **S. W. J. Smith.** (Phys. Soc., Proc. 21. pp. 684–703; Discussion, p. 702, Dec., 1909.)

1662. *Effect of Sulphur and Silicon on Cast Iron.* **J. E. Stead.** (Mech. Eng. 26. pp. 431–433, Sept. 30, and pp. 484–488, Oct. 14, 1910. Address to Chemical Section of the British Assoc. at Sheffield.)

1663. *Physical Properties of Binary Liquid Mixtures.* **J. C. Hubbard.** (Phys. Rev. 30. pp. 740–765, June, 1910.)—An investigation of the vapour pressure, specific volume, and index of refraction. The substances employed were: Benzol, ethyl acetate and iodide, carbon tetrachloride, acetic acid, chloroform, acetone, methylal and carbon disulphide.

1664. *Potential of the Thallium Electrode.* **G. N. Lewis** and **C. L. v. Ende.** (Amer. Chem. Soc., Journ. 32. pp. 732–741, June, 1910.)